CLAIMS

What is claimed is:

1. A temperature control device comprising:

an interface surface configured to provide a thermal path to a device under test ("DUT");

a fluid-cooled heat sink having a first heat transfer portion in a first plane and a second heat transfer portion in a second plane, said first plane being closer to said interface surface than said second plane; and

one or more integral heater assemblies.

2. A temperature control device according to claim 1, further comprising one or more thermal sensing elements.

3. A temperature control device according to claim 1, wherein said first heat transfer portion includes one or more flow channels and said second heat transfer portion includes one or more flow channels.

4. A temperature control device according to claim 1, wherein said first heat transfer portion has a flow path in a first direction and said second heat transfer portion has a flow path in a second direction.

5. A temperature control device according to claim 4, wherein said flow path in said first direction is opposite to said flow path in said second direction.

6. A temperature control device according to claim 1, wherein said one or more integral heater assemblies are planar and parallel to said interface surface.

7. A temperature control device according to claim 1, wherein said one or more integral heater assemblies includes a substrate and at least one heating element formed on said substrate.

8. A temperature control device according to claim 7, wherein said at least one heating element comprises one or more electrically resistive serpentine traces.

9. A temperature control device according to claim 1, wherein each of said one or more integral heater assemblies has an independently adjustable power level.

10. A temperature control device comprising:

an interface surface configured to provide a thermal path to a device under test ("DUT");

a fluid-cooled heat sink structure configured to maintain a cross-flow of coolant in three dimensions for cooling said interface surface; and

a heater assembly configured to heat said interface surface.

11. A temperature control device according to claim 10, wherein said fluid-cooled heat sink structure comprises:

a first fluid conduit for accommodating coolant flow in a first direction;

a first three-dimensional microchannel structure located within said first fluid conduit, said first microchannel structure being configured to direct coolant flow in three dimensions within said first fluid conduit;

a second fluid conduit for accommodating coolant flow in a second direction different than said first direction; and

a second three-dimensional microchannel structure located within said second fluid conduit, said second microchannel structure being configured to direct coolant flow in three dimensions within said second fluid conduit.

12. A temperature control device according to claim 11, wherein said first and second fluid conduits are coplanar.

13. A temperature control device according to claim 12, wherein said first and second fluid conduits are adjacent to each other.

14. A temperature control device according to claim 11, wherein:

said first fluid conduit is located above said second fluid conduit; and

said first and second fluid conduits are located above said interface surface.

15. A temperature control device according to claim 10, wherein said heater assembly is located between said interface surface and said fluid-cooled heat sink structure.

16. A temperature control device according to claim 10, wherein said fluid-cooled heat sink structure comprises:

a first layer;

a second layer below said first layer;

a first plurality of flow channels, formed in said first layer, for accommodating coolant flow within said fluid-cooled heat sink structure; and

a second plurality of flow channels, formed in said second layer, for accommodating coolant flow within said fluid-cooled heat sink structure.

17. A temperature control device according to claim 16, wherein said first and second layers are parallel to each other.

18. A temperature control device according to claim 16, wherein:

said first plurality of flow channels are configured to maintain a first flow path having a first direction; and

said second plurality of flow channels are configured to maintain a second flow path having a second direction different than said first direction.

19. A temperature control device according to claim 18, wherein said first flow path is opposite to said second flow path.

20. A temperature control device comprising:

an interface surface configured to provide a thermal path to a device under test ("DUT"); and

a fluid-cooled heat sink structure configured to maintain a cross-flow of coolant in three-dimensions for cooling said interface surface, said fluid-cooled heat sink structure comprising:

a first fluid conduit for accommodating coolant flow in a first direction;

a first three-dimensional microchannel structure located within said first fluid conduit, said first microchannel structure being configured to direct coolant flow in three dimensions within said first fluid conduit;

a second fluid conduit for accommodating coolant flow in a second direction different than said first direction; and

a second three-dimensional microchannel structure located within said second fluid conduit, said second microchannel structure being configured to direct coolant flow in three dimensions within said second fluid conduit.

21. A temperature control device according to claim 20, further comprising a heater assembly configured to heat said interface surface.

22. A temperature control device according to claim 20, wherein said first and second fluid conduits are coplanar.

23. A temperature control device according to claim 20, wherein:

said first fluid conduit is located above said second fluid conduit; and

said first and second fluid conduits are located above said interface surface.